

**ARTICLE:****Bluetooth Technology: The Convergence Of Communications And Computing**

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Imagine that you are in a meeting with your notebook computer open in front of you. Suddenly, the cursor begins to blink and a new e-mail message is displayed on the screen. Your computer isn't plugged into anything, your cellular phone is in your briefcase under the table, but you are receiving e-mail over the wireless network. How is this possible?

Your notebook is communicating with your cell phone, which in turn is communicating with the wireless network through a revolutionary new radio chip developed through a collaboration of the computing and communications industries—code name "Bluetooth."

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**Setting the Stage**

Over the past ten years, the communications and computer industries have developed new technology products that enable mobile workers to be more productive.

The communications industry has given us pagers that can receive and display text messages, mobile phones that weigh only a few ounces, and mobile phone coverage virtually everywhere we go, while the computer industry has provided portable computers that have evolved from luggables to palmtops. As a result, our work force is able to spend more working hours in the field.

During this same time, first facsimile, and now electronic mail have taken us beyond voice communications. Today's mobile workers need the ability to access their own e-mail, connect to their corporate information resources, and perhaps to send and receive faxes.

Thus the next logical step was for the computing and communications industries to work together to provide wireless access to computing devices. For five or six years, the industries have been doing just that—working together toward providing customers with the same level of access to their computing data as they have to people via their mobile phones.

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### **Enter Digital**

All of the new wireless voice systems being implemented today are based on digital technologies, as are data-only networks. Meanwhile, most analog wireless networks are being upgraded to digital. Digital networks are better suited to data, and most are capable of providing for both voice and data. Even so, it is still necessary to purchase a wireless network adapter or modem as well as proprietary cables and connectors for the computer in order to use these networks for wireless data.

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### **Problems Remain**

Even with today's renewed interest, and technical advances made by both industries, implementing wireless data remains a complex and expensive proposition. Because there are so many wide-area networks that can be used for wireless data, and there are so many digital standards, computer vendors have been frustrated in their efforts to build wireless communications solutions into their mobile computers.

As a result, communications companies have had to find ways to enable their communications devices in the computing world.

Eventually, several companies from both industries decided that they needed to work together to find a common solution. They knew that there was a demand to merge mobile computing with mobile communications, and they understood the problems. They believed that working together they could find a solution.

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### **The Result**

The result of this collaboration will be a technology code-named "Bluetooth." I expect this to address all of the issues raised above, and it provides a common solution for both industries. The model for Bluetooth is simple, and there is genius in its simplicity.

Rather than trying to design computers so they will work with any wireless interface card or modem on any frequency, using any one of a number of digital technologies, why not build a single, common radio into every mobile computer?

The computer and radio combination could then be optimized to minimize interference—a task made easier for computer engineers with only one radio. With a single-radio solution, computer vendors are no longer faced with having to make a network choice or supporting multiple networks.

The Bluetooth communications device is a small, low-powered radio in a chip that will "talk" to other Bluetooth-enabled products, eliminating the need for cables or infrared beams to connect portable computers, cellular phones, printers, fax machines, etc. It will be possible to connect enabled devices on a one-to-one or one-to-many basis.

Since the chip supports both voice and data communications, applications will range from something as simple as replacing the cable between a mobile computer and cellular phone,

to more complex connections involving multiple computers, and extending into hands-free voice communications for wireless phones in vehicles.

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#### **A Win for the Computer Industry**

Bluetooth appears to be a win for the computer industry. Most computer manufacturers have wanted to enable wireless communications but have been unable to determine which wide-area networks to support. The Bluetooth solution eliminates the need for a wide-area network decision. This can be left to the makers of phones and modems and other wide-area network devices. As an added bonus, the radio, which is inexpensive to build in, can be used to connect any two or more devices that are equipped with the radio module.

Computer manufacturers have known for some time that wireless communications will be important for mobile computers. The Bluetooth solution provides a short-range *ad hoc* network, enabling users to send and receive e-mail without a phone and synchronize their calendar and phone book automatically whenever the two devices detect each other's presence.

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#### **The Communications Industry**

Bluetooth also appears to be a win-win for the communications industry. Communications companies will no longer have to build external cables and PC Cards to enable their wireless phones and network cards to interface to computers. A Bluetooth module built into the phone or wireless network connection points will enable it to send and receive information to and from any computer so equipped.

Since Bluetooth is capable of short-range voice communications as well, it will also be used as a hands-free voice interface for cellular phones, a speaker-phone link, and a link between the phone and other electronics in an automobile. Bluetooth technology enables multiple devices to communicate with each other using a common set of standards when they are within range.

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#### **Built-In Devices**

The "compelling" reasons for incorporating Bluetooth are to wirelessly connect mobile computers to cellular phones, and to establish small workgroups quickly and easily. As the number of Bluetooth-equipped devices grows, so will their uses. Printers, fax machines, LANs, and more will be able to communicate with each other.

On the communications side, cellular phones, two-way pagers, wireless data-only terminals, and most other two-way wireless-capable devices will be Bluetooth-equipped. Bluetooth will provide the "glue" for the merger of wireless and computers. And it provides some great new voice options as well.

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### **Add-In and Add-On**

While I expect to see many new computer products that include radio modules to enter the marketplace, I also expect to see many computer companies build add-in and add-on modules to enable existing wireless and computing combinations. Soon after such products come to market, I expect to see printer and network adapters as well as adapters for wireless phones and mobile computers already on the market.

Bluetooth is a universal solution to what has been a perplexing connectivity problem, and I expect to see wide adoption of this technology. It is being packaged for the OEM as a certified module at a low cost—I think that it is a "no-brainer" when it comes to deciding whether to build the technology into new products.

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### **A Look at Bluetooth**

The Bluetooth wireless technology will use one of the available unlicensed, yet virtually worldwide radio bands—2.4 GHz—and it can support both voice and data. Everything needed to be Bluetooth-capable will be contained in a module that will cost between \$15 and \$20 at first. Driven by volume, the cost should drop to about \$5 by 2001.

The low-power radio module can and will be built into mobile computers, mobile phones, printers, fax machines, and network connection points. While its primary focus is to be the wireless connection between mobile computers and/or between computers and wireless network devices such as cellular phones, Bluetooth supports data speeds of up to 721 Kbps (including a 56 Kbps back channel) as well as three voice channels.

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### **Specs and Design**

The Bluetooth design is a collaborative effort between communications and computing companies. Ericsson and Nokia independently were working on similar radio concepts. They understood the need for a partner on the computer side and independently approached Intel with the idea. Intel quickly grasped the importance of the concept and has been instrumental in driving the concept to reality. The initial group working on Bluetooth also includes IBM, Toshiba, Motorola, and Palm (3Com). Because of close collaboration and input from both industries in the final design, Bluetooth will provide flexibility that reaches beyond simply being a replacement for wire.

Bluetooth has been designed to operate in a multi-user environment. Devices can be enabled to communicate with each other by the computer or communications device end user. Up to eight users or devices can make up a piconet, and ten piconets can co-exist in the same coverage range. Since each link is encoded and protected against both eavesdropping and interference, Bluetooth can be considered a secure short-range wireless network.

The balance of the specifications are as follows<sup>1</sup>:

Frequency Band: 2.4 GHz (unlicensed ISM Band)

Transmitter Power: 1 milliWatt (0 dBm)

Technology: Spread Spectrum

Hybrid Direct sequence and frequency hopping

Maximum Voice Channels: 3 per piconet

Maximum Data Channels: 7 per piconet

Data speed: 721 Kbps per piconet

Expected System Range: 10 meters (40 feet)

Number of Devices Supported: 8 per piconet, 10 piconets in coverage area<sup>2</sup>

Security: Yes, link layer

Power Requirement: 2.7 volts

Power Consumption: 30 uA sleep, 60 uA hold, 300 uA standby

8-30 mA transmitting

Module size: 0.5 square inches

Interference: Bluetooth minimizes potential interference by employing fast frequency hopping—1600 times a second.

<sup>1</sup> Features currently planned are subject to change without any notice. Actual features may vary.

<sup>2</sup> Graceful degradation of the symbol rate for more than 10 piconets in a given coverage area.

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## Conclusions

I am really excited about this technology and what it will mean to mobile computing and communications. To me, Bluetooth represents a no-brainer concept at a reasonable price. I believe that any computer vendor building mobile devices should embrace this concept and these products—immediately if not sooner!

The same goes for mobile phone, wireless modem, and network adapter vendors. While it

might take a while for this module to show up in smaller phones, most can certainly accommodate the module when it comes to size and current drain. As the number of Bluetooth devices on the market increases, prices for the module will continue to come down to a point where it is comparable to building in IrDA-compliant infrared, which is a common practice today.

I also believe that printer, fax, and other accessory device vendors will be quick to hop on the Bluetooth bandwagon. Imagine being able to print without cables or aiming an infrared beam. Imagine walking into your office and putting your briefcase down and having the notebook computer inside it automatically sense that it is in range of your desktop and initiate the exchange of data to update both systems.

Of course, the primary advantage to this system is that computer vendors *can build it in*. They don't have to worry about choosing a wide-area network to support, or stocking an assortment of modules for several networks. And their engineers need only minimize interference for *one* radio on *one* frequency band! Further, enabling their computers for wireless data communications will not require a PC Card slot or option bay cavity—these will remain available for other uses.

Bluetooth has been designed to solve a number of connectivity problems experienced by mobile workers and consumers. And it does so in a simple, neat package that is inexpensive—the OEM only pays for the cost of the module. The system is available royalty and license free.

Bluetooth was well conceived, and I believe that it will be well received. I will certainly encourage all of my clients to make Bluetooth a part of their strategy as they move forward. My only disappointment is that I have to wait until mid-1999 before I can have a Bluetooth-enabled set of mobile computing and communications devices.

For more information about Bluetooth, visit [www.bluetooth.com](http://www.bluetooth.com).

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